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United States
Department of
Agriculture

Forest Service

Forest
Products
Laboratory

DIVIDENDS FROM WOOD RESEARCH

Recent Publications

July-December 1985

instructions and explanation

"Dividends From Wood Research" is a semiannual listing of recent publications resulting from wood utilization research at the Forest Products Laboratory (FPL). These publications are produced to encourage and facilitate application of Forest Service research. This issue lists publications received from the printer by the FPL Publications Section between July 1, 1985, and December 31, 1985.

Each publication listed in this brochure is available through at least one of the sources below. For each entry in the brochure, we indicate the primary source for that publication and show you how to obtain a copy:

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list of categories

Publications are listed in this brochure within the following general categories:

Anatomy and identification
Biotechnology
Chemicals and energy
Composite products and adhesives
General
Material properties and construction
Mycology
Packaging
Preservation and protection
Processing of lumber
Pulp and paper
Timber requirements and economics

anatomy and identification

Measuring Microfibrillar Angles Using Light Microscopy

Senft, John F.; Bendtsen, B. Alan
Wood Fiber Sci. 17(4): 564-567; 1985. (Available from Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN 47907. Cost unknown.)

A rapid, reliable method of enhancing microfibrillar angles for viewing in wood cell walls, a modification of I. W. Bailey's technique, is reviewed. Dried microtomed sections are treated with an iodine-potassium iodide solution and nitric acid to produce crystals in cell walls of softwood tracheids or hardwood fibers. The crystals are aligned with the predominant microfibrillar angle and may be easily viewed and measured.

1. Vestured Pits in the Tribe Cassieae Bronn (Leguminosae)

Quirk, J. T.; Miller, R. B.
IAWA Bull. n.s. 6(3): 200-212; 1985.

The woods of 15 genera of the tribe Cassieae and 4 genera of the Cercideae were studied for presence or absence of vestured pits. Vestured pits are absent form the subtribes Dialiinae, Duparquetiinae, and Labicheinae and from all Cercideae studied. These results are compared with variation patterns in other wood anatomical features and discussed in terms of tribal delimitation and affinities between subtribes in this part of the Leguminosae.

A 13.27/7-2:

biotechnology

2. Degradation of Gymnosperm (*Guaiacyl*) vs. Angiosperm (Syringyl/Guaiacyl) Lignins by *Phanerochaete chrysosporium*

Faix, Oskar; Mozuch, Michael D.; Kirk, T. Kent
Holzforschung. 39: 203-208; 1985.

This study examined the relative degradabilities of guaiacyl and syringyl-guaiacyl lignins by the white-rot fungus *Phanerochaete chrysosporium* Burds. Synthetic syringyl-guaiacyl lignin ($^{14}C_\beta$ in syringyl units) was depolymerized much more rapidly than synthetic guaiacyl lignin ($^{14}C_\beta$), although the two were oxidized to $^{14}CO_2$ at the same rate. Milled wood lignin or birch, labeled with ^3H at C_α, was also depolymerized more rapidly than similarly labeled spruce milled wood lignin. During degradation two to three times as much of both the synthetic and natural guaiacyl lignins became mycelium-bound as the syringyl-guaiacyl lignins. This result is interpreted to reflect a greater resistance of the guaiacyl lignins. Collectively, the results point to a more facile *initial* degradation of the syringyl-guaiacyl type of lignins. This finding helps explain the more rapid degradation of angiosperm wood than gymnosperm wood by white-rot fungi.

3. Mechanism of Oxidative C_α-C_β Cleavage of a Lignin Model Dimer by *Phanerochaete chrysosporium* Ligninase

Hammel, Kenneth E.; Tien, Ming; Kalyanaraman, B.; Kirk, T. Kent
J. Biol. Chem. 260(14): 8348-8353; 1985.

The hemoprotein ligninase of *Phanerochaete chrysosporium* Burds. catalyzes the oxidative cleavage of lignin model dimers between C_α and C_β of their propyl side chains. The model dimers hitherto used give multiple products and complex stoichiometries upon enzymatic oxidation. Here we present experiments with a new model dimer, 1-(3,4-dimethoxyphenyl)-2-phenylethanediol (dimethoxyhydrobenzoin, DMHB) which is quantitatively cleaved by ligninase in air to give benzaldehyde and veratraldehyde according to the stoichiometry: $2DMHB + O_2 \rightarrow 2PhCHO + 2Ph(OMe)_2CHO$. Catalytic amounts of H_2O_2 are required for this aerobic reaction. Under anaerobic conditions, ligninase uses H_2O_2 as the oxidant for cleavage: $DMHB + H_2O_2 \rightarrow PhCHO + Ph(OMe)_2CHO$. Electron spin resonance experiments done in the presence of spin traps, 2-methyl-2-nitrosopropane or 5,5-dimethyl-1-pyrroline-*N*-oxide, show that C_α-C_β cleavage yields α-hydroxybenzyl radicals as intermediate products. Under anaerobic conditions, these radicals react further to give the final aldehyde products. In air, O_2 adds to the carbon-centered radicals, probably giving α-hydroxy-benzylperoxyl radicals which fragment to yield superoxide, benzaldehyde, and veratraldehyde. These results lead us to propose a mechanism for C_α-C_β cleavage in which attack by ligninase and H_2O_2 on the methoxylated ring of DMHB yields a cation radical, which then cleaves to give either benzaldehyde and an α-hydroxy (dimethoxybenzyl) radical or veratraldehyde and an α-hydroxybenzyl radical.

4. Dechlorination of Chloro-Organics by a White-Rot Fungus

Huynh, Van-Ba; Chang, Hou-min; Joyce, Thomas W.; Kirk, T. Kent
Tappi J. 68(7): 98-102; 1985.

Numerous chlorinated organics are produced during the bleaching of pulp with chlorine. These compounds are known to be hazards in the environment, and their discharge may be regulated in the future. A wastewater treatment system using a white-rot fungus is able to degrade these chlorinated compounds. Mechanisms for degradation include methylation, oxidation, and reduction.

5. Production of Ligninases and Degradation of Lignin in Agitated Submerged Cultures of *Phanerochaete chrysosporium*

Jager, Alexander; Croan, Suki; Kirk, T. Kent
Appl. Environ. Microbiol. 50(5): 1274-1278; 1985.

Research on the extracellular hemeprotein ligninases of *Phanerochaete chrysosporium* has been hampered by the necessity to produce them in stationary culture. This investigation examined the effects of detergents on development of ligninase activity in agitated submerged cultures. Results show that addition of Tween 80, Tween 20, or 3-[(3-colamidopropyl)dimethylammoniol]1-propanesulfonate to the cultures permits development of ligninase activity comparable to that routinely obtained in stationary cultures. The detergent-amended cultures express the entire ligninolytic system, assayed as the complete oxidation of [^{14}C]lignin to $^{14}CO_2$. The detergent effect is evidently not merely in facilitating release of extant enzyme. Development of ligninolytic activity in the agitated cultures, as in stationary cultures, is idiophasic. Ion-exchange fast protein-liquid chromatography indicated that the heme protein profiles in agitated and stationary cultures are very similar. These findings should make it possible to scale up production of ligninolytic enzymes in stirred tank fermentors.

6. Emerging Technology for Fermenting D-Xylose

Jeffries, Thomas W.
Trends in Biotechnology. 3(8): 208-212; 1985.

In the past four years, numerous yeasts which convert D-xylose to ethanol have been reported. The conversion occurs most readily under aerobic conditions. Various aspects of this conversion have provided new insight into the mechanisms and metabolic regulation of ethanol fermentation in yeasts. Although specific fermentation rates, product yields and product concentrations are significantly lower with D-xylose than with D-glucose, technology is emerging which may prove to be feasible for commercial fermentation of D-xylose-containing waste streams.

7. Growth and Development of *Lentinus edodes* on a Chemically Defined Medium

Leatham, Gary F.
In: Moore, D.; Casselton, L. A.; Wood, D. A.; Frankland, J. C., eds. Developmental Biology of Higher Fungi. British Mycological Society Symposium 10; 1984 April; University of Manchester [Manchester, England]. Cambridge, England: Press Syndicate of the University of Cambridge; 1985: 403-427.

The single largest bioconversion process utilizing wood is currently the cultivation of *Lentinus edodes*. The Orient cultivates more than U.S. $1 billion of this edible mushroom each year. This lignin-degrading basidiomycete is cultivated primarily out of doors on hardwood logs.

Recently, a chemically defined medium was developed that rapidly fruits *L. edodes*. Using this medium and a fractionation technique, the author studied the growth and develoment of *L. edodes*. The areas studied were carbon and nitrogen source uptake and utilization, soluble protein content, and several extractable enzymes that may be important in development.

8. Extracellular Enzymes Produced by the Cultivated Mushroom *Lentinus edodes* During Degradation of a Lignocellulosic Medium

Leatham, Gary F.
Appl. Environ. Microbiol. 50(4): 859-867; 1985.

Although the commercially important mushroom *Lentinus* (= *Lentinula*) *edodes* (Berk.) Sing. can be rapidly cultivated on supplemented wood particles, fruiting is not reliable. This study addressed the problem by developing more information about growth and development on a practical oakwood-oatmeal medium. The study determined (a) the components degraded during a 150-day incubation at 22 °C, (b) the apparent vegetative growth pattern, (c) the likely growth-limiting nutrient, and (d) assays that can be used to study key extracellular enzymes. All major components of the medium were degraded, lignin selectively so. The vegetative growth rate was most rapid during the initial 90 days, during which weight loss correlated with glucosamine accumulation (assayed after acid hydrolysis). The rate then slowed; in apparent preparation for fruiting, the cultures rapidly accumulated glucosamine (or its oligomer or polymer). Nitrogen was growth limiting.

chemicals and energy

9. Charcoal Industry in the U.S.A.

Baker, A. J.
In: Symposium on Forest Products Research International—Achievements and the Future, Vol. 5; 1985 April 22-26; Pretoria, Republic of South Africa. South African Council for Scientific and Industrial Research, National Timber Research Institute; 1985.

A history and a description of the production methods are given for the charcoal industry in the United States. Kilns and continuous retorts are used to produce the charcoal required to make nearly 800,000 tons (725,000 metric tons) of briquets per year. Nearly all the charcoal is used for cooking. There is potential for use of high-strength charcoal in cupola furnaces.

10. Differential Scanning Calorimetry of Phenol-Formaldehyde Resols

Christiansen, A. W.; Gollob, L.
J. Applied Polymer Sci. 30: 2279-2289; 1985.

Differential scanning calorimetry was used on a range of synthesized phenol-formaldehyde (PF) resols to discover relationships between formulation parameters or physical properties of resols, and their thermal behavior during cure. The thermograms showed either one or two exothermic reactions. The lower exothermic peak temperature varied between 98 and 129 °C with changes in the free formaldehyde content. The upper exothermic peak temperature varied from 139 to 151 °C, with the higher temperatures occurring when the formaldehyde-to-phenol molar ratio was low or the total amount of sodium hydroxide relative to phenol was high. These two factors led to resins which contain a somewhat higher level of unreacted *ortho* or *para* aromatic ring positions and no free formaldehyde.

11. Kinetic Modeling of Hardwood Prehydrolysis. Part II. Xylan Removal by Dilute Hydrochloric Acid Prehydrolysis

Conner, Anthony H.; Libkie, Kimball; Springer, Edward L.
Wood Fiber Sci. 17(4): 540-548; 1985.

Knowledge of prehydrolysis kinetics has applicability to the design, development, and modeling of processes to separate wood into its basic chemical constituents (i.e., cellulose, hemicellulose, and lignin). The kinetics of xylan hemicellulose removal with 0.10 M HCl at 120 C from quaking aspen, paper birch, American elm, red maple, and southern red oak was studied. The mathematical model developed in Part I to describe the kinetics of xylan removal by water prehydrolysis of these species could be used to model xylan removal with dilute hydrochloric acid. Xylan removal could thus be modeled as the sum of two parallel first-order reactions—one fast and one slow. However, unlike the case with water prehydrolysis where the rate constants for the fast (k_f) and slow (k_s) reaction processes could be correlated with each other, they could not be correlated for HCl prehydrolysis. Instead the k_f and k_s values determined for each species clustered about average k_f and k_s values for all the species as a whole. A single set of parameters determined from a nonlinear least squares fit of the experimental prehydrolysis data for all the species as a whole to the model could be used to reasonably describe the course of xylan removal from all the species.

12. Two-Stage, Dilute Sulfuric Acid Hydrolysis of Wood: An Investigation of Fundamentals

Harris, John F.; Baker, Andrew J.; Conner, Anthony H.; Jeffries, Thomas W.; Minor, James L.; Pettersen, Roger C.; Scott, Ralph W.; Springer, Edward L.; Wegner, Theodore H.; Zerbe, John I.

USDA Forest Serv. Gen. Tech. Rep. FPL-45; 1985.

This paper presents a fundamental analysis of the processing steps in the production of ethanol from southern red oak (*Quercus falcata* Michx.) by two-stage dilute sulfuric acid hydrolysis. Data for hemicellulose and cellulose hydrolysis are correlated using models. This information is used to develop and evaluate a process design.

13. Dilute Acid Hydrolysis of Paper Birch: Kinetics Studies of Xylan and Acetyl-Group Hydrolysis

Maloney, Mark T.; Chapman, Thomas W.; Baker, Andrew J.
Biotechnol. Bioeng. 27: 355-361; 1985.

Batch hydrolysis kinetics of paper birch (*Betula papyrifera*) xylan and its associated acetyl groups in dilute sulfuric acid have been measured for acid concentrations of between 0.04 and 0.18*M* and temperatures of between 100 and 170 °C. Only 5% of the cellulose was hydrolyzed for up to 85% xylan removal. Rate data were correlated well by a parallel reaction model based on the existence of reactive and resistant xylan portions. The resulting rate equation predicts the experimental xylan concentrations in the residue to within 10%. Hydrolysis of xylan-associated acetyl groups was found to occur at the same rate as that of xylan, except at 100 °C, where acetyl is released preferentially. No effect of acid concentration on the rate of acetyl removal relative to that of xylan was evident.

14. Procedures for Determining the Neutralizing Capacity of Wood During Hydrolysis with Mineral Acid Solutions

Springer, Edward L.; Harris, John F.
Ind. Eng. Chem. Prod. Res. Dev. 24: 485-489; 1985.

Those anions present in wood that are associated with inorganic cations neutralize part of the mineral acid added to wood to catalyze hydrolysis. The resulting reduced hydronium ion concentration proportionally reduces the rates of hemicellulose and cellulose hydrolysis. Hydronium ion concentration is a fundamental variable in the kinetics of hydrolysis. In this study procedures were developed for determining the neutralizing capacity of wood and hydrolysis residues so that hydronium ion concentration can be accurately determined in low pH hydrolysis solutions at reaction conditions. The neutralizing capacity of wood was found to depend on the reaction conditions employed. All anions in wood associated with inorganic cations are not active in neutralization even under the most severe prehydrolysis conditions. Hydronium ion concentrations in hydrolysates calculated from wood neutralizing capacities agreed well with those determined by a kinetic method.

15. Current Developments in the Conversion of Wood to Liquid Fuels

Zerbe, J. I.
In: Symposium on Forest Products Research International—Achievements and the Future, Vol. 5; 1985 April 22-26; Pretoria, Republic of South Africa. South African Council for Scientific and Industrial Research, National Timber Research Institute; 1985.

This report covers the possibilities for making liquid fuels from wood with particular emphasis on a two-stage process for producing ethanol. The process is dependent on dilute acid hydrolysis. Other processes and other liquid fuels are described, including methanol derived from wood by gasification.

READEX FICHE

composite products and adhesives

16. The Proportional Limits of Lateral Nail Resistance in Structural Wood Composites

Chow, Poo; McNatt, J. D.; Youngquist, J. A.
In: Symposium on Forest Products Research International—Achievements and the Future, Vol. 4; 1985 April 22-26; Pretoria, Republic of South Africa. South African Council for Scientific and Industrial Research, National Timber Research Institute; 1985.

Little information is available in the literature on the load-deformation level at the proportional limit or elastic behavior of the lateral nail resistance in new structural wood-base sheathing and siding panel products, especially in accelerated aging condition, compared to conventional plywood sheathing material. Five kinds of materials were tested under three exposure conditions, three test methods, and two face grain directions. A replication size of 20 tests was used. The results show that all main factors had significant influences, with the exception of face grain direction, on elastic property of lateral resistance of all specimens.

Effects of Test Methods and Exposure Conditions on Lateral Nail and Staple Resistance of Wood-Base Panel Materials

Chow, Poo; McNatt, J. Dobbin; Janowiak, John J.; Gertner, George Z.
Forest Prod. J. 35(9): 13-19; 1985. (Copies available from Poo Chow, 110 Mumford Hall, 1301 West Gregory Drive, University of Illinois, Urbana, IL 61801. No charge.)

Three test methods were compared as to their suitability for determining the lateral nail resistance of wood-base panel materials: the standard ASTM D1037 method, the American Plywood Association (APA) performance method, and a newly developed method in which a reinforced steel bar replaces the 6d nail. Lateral staple resistance was also measured by a modified Forest Products Laboratory (FPL) test method. Plywood, composite plywood, waferboard, oriented strandboard, and hardboard siding were evaluated. Edge distances were 1/2 and 3/8 inch. The steel bar method was the most efficient and reliable test to determine lateral nail resistance. Its only shortcoming is the extra step needed to machine a slot in each specimen in order to fit the test jig. The ASTM D1037 test was slower, but reliable, since the nail-bending problem did not affect the maximum lateral nail resistance value. The APA test produced results between 60 and 70 percent of the D1037 and steel bar tests. The APA lateral nail test and the FPL lateral staple test produced a fastener head pullthrough type failure.

17. A Search for Nondestructive Acid Catalysts for Wood Bonding

Christiansen, Alfred W.
Forest Prod. J. 35(9): 47-54; 1985.

Acid catalysts for bonding exterior-grade wood products would allow use of several potential new adhesives and would increase cure speeds for phenolic adhesives. The problem is that the acid leaches out of the bondline to attack nearby wood, leading to serious declines of initially high strengths. A novel approach to stop acid movement was investigated: selecting sulfonic acids that might become chemically or physically trapped within the cross-linked adhesive structure. An acid-curable phenolic resol was used as the model adhesive. The relative catalytic effectiveness of acids was judged by calorimetric measurements. Both aqueous extractions of acid from cured resin and strength durability measurements on bonded wood specimens were used to judge how well the concept worked. Toluenesulfonic acid, used as a control catalyst, was the most effective acid, per equivalent of acid, in accelerating the resin cure. None of the acids tested was significantly retained within the resin upon extraction. This indicates that the phenolic resin is somehow porous to even the large catalyst molecules. At acid levels needed to give faster cures than alkaline catalysts, bond strengths degraded as much as 30 percent during 8 weeks of accelerated moist aging. Degradation correlated with initial acid level.

18. The Role of Adhesives in the Improved Use of Our Timber Resources

Erickson, John R.
J. Adhesion. 18: 273-280; 1985.

Adhesives are extremely important to our wood products industry. Most of the wood products we use are reconstituted or bonded in some manner. Continual improvements in adhesives and adhesion science have led to an array of new wood products that have profoundly affected the management of our forest resources. A variety of particleboard products utilizes residues from the forest and primary processing plants, greatly extending our timber supply. Laminated structural members can be manufactured from smaller trees, thus permitting shorter rotations and better forest management. These are but a few examples of the technical advances in wood use made possible by adhesives. Future improvement in wood use will require a continued strong RD&A program in adhesives and bonding systems.

19. Steam-Injection Pressing of Isocyanate-Bonded Aspen Flakeboards: Latitudes and Limitations

Geimer, Robert L.
USDA Forest Serv. Res. Pap. FPL 456; 1985.

Injection of steam into a flakeboard mat during pressing significantly reduces press times. One-half-inch-thick 0.640 specific gravity (SG) isocyanate-bonded aspen flakeboard can be cured in 60 seconds by injecting 99 Btu's of steam energy per pound (Btu/lb) of board. Press time may be reduced to 40 seconds when energy consumption is increased to 177 Btu/lb of board. Two-inch-thick 0.640 SG board can be pressed in 201 seconds with 185 Btu/lb. Blister formation in high-density thin boards and temperature variation in low-density thick boards were compensated for with press cycles individually suited for each combination of board thickness and SG.

20. Influence of Processing-Induced Damage on Strength of Flakes and Flakeboards

Geimer, Robert L.; Mahoney, Robert J.; Loehnertz, Stephen P.; Meyer, Robert W.
USDA Forest Serv. Res. Pap. FPL 463; 1985.

Research was conducted to explore the effect of flake quality on the strength of Douglas-fir flakeboard. High-quality (grade A) flakes prepared with finely honed knives set in a close tolerance disk flaker were compared to low-quality (grade B) flakes made with dull knives and dry wood. The flakes could be visually categorized into the two broad quality groups; however no method was found to refine the classification system. Flake quality determined to a large extent the strength properties of hot-pressed boards. No microscopic internal damage could be attributed to the flaking process. However, both grades of quality flakes suffered internal damage during hot pressing. Tensile strength tests on individual flakes indicated that high press temperatures favor flake strength.

21. A Design Approach for Mixed Hardwood Structural Flakeboard

Hunt, M. O.; Hoover, W. L.; Lattanzi, R. C.; Youngquist, J. A.
In: Robertson, Doris, coord. Structural wood composites: Meeting today's needs and tomorrow's challenges: Proc. 7339; 1984 November 12-14; Minneapolis, MN. Madison, WI: Forest Prod. Res. Soc.; 1985: 164-172.

Single species, aligned woodstrand panels were produced and tested for the development of regression equations to predict the single-layer properties of a multilayered panel. The input parameters included in the models were flake length, flake thickness, flake alignment, and panel density. Mixed species panels were then produced to test whether the properties of mixed species layers can be predicted as a weighted-average of the single-species prediction equations, the so-called rule of mixtures. This technique successfully predicted all properties except plate shear modulus and internal bond. It is proposed to use this approach to design multilayered, mixed-species structural panels.

22. Potential for Structural Lumber Substitutes

Laufenberg, Theodore L.
In: Robertson, Doris, coord. Structural wood composites: Meeting today's needs and tomorrow's challenges: Proc. 7339; 1984 November 12-14; Minneapolis, MN. Madison, WI: Forest Prod. Res. Soc.; 1985: 41-53.

The potential for substitution of structural wood composites into solid-sawn lumber markets is presented from the technological viewpoint. Technological limitations of existing composite processes and products are reviewed in the context of the present laminated veneer lumber (LVL), flakeboard, and fiber/paper industries. The limits of mechanical property potential are presented to show that strength and stiffness may be enhanced through innovative processing of structural wood composites.

23. Design and Processing of Composite Wood Structural Components

Laufenberg, Theodore L.
In: Advancing technology in materials and processes, Vol. 30; 1985 March 19-21; Anaheim, CA. Covina, CA: Society for the Advancement of Material and Process Engineering; 1985: 111-119.

Decreasing size and quality of the nation's forest resources and continued research are making the use of composite wood structural components economical. This paper details the design and processing options available for structural components such as shear panels, I-beams, joists, trusses, and wall and floor systems made from wood composites.

24. Flakeboard Fracture Surface Observations and Correlation with Orthotropic Failure Criteria

Laufenberg, Theodore L.
J. Institute Wood Sci. 10(2): 57-65; 1984.

The failure surfaces of random flakeboards were studied by microscope to evaluate the utility of traditional orthotropic failure criteria in predicting of microstructural failure mechanisms. Test flakeboards were manufactured with varied flake thickness, resin content, and compaction pressure to provide a broad range of failure surface characteristics. Failure surfaces included flakes exhibiting four distinctly different phenomena: transverse/shear (80 percent of all occurrences); rolling shear failures (8 percent); tension failures (4 percent); and flakes that had disbonded from adjoining material (8 percent). The type of failure surface generated was found to be closely associated with the fiber angle of the flake.

25. Fiberboard and Hardboard Research at the Forest Products Laboratory: A 50-Year Summary

Myers, Gary C.; McNatt, J. Dobbin
USDA Forest Serv. Gen. Tech. Rep. FPL-47; 1985.

Many changes have occurred in the fiber-based panel products industries during the past 50 years. During this timespan the Forest Products Laboratory has conducted a considerable amount of research on processing and product evaluation of fiber-based panel product materials. Unfortunately about 26 percent of this information was never published. This report compiles all of the studies completed during this timespan and briefly summarizes what was accomplished.

26. Effect of Separate Additions to Furnish or Veneer on Formaldehyde Emission and Other Properties: A Literature Review (1960-1984)

Myers, George E.
Forest Prod. J. 35(6): 57-62; 1985.

This is the third in a planned series of six critical reviews of the literature on different aspects of the problems of formaldehyde emission from adhesively bonded wood products. This paper examines the available data on effects of separate additions of formaldehyde scavengers to furnish or veneer on formaldehyde emission from particleboard and hardwood plywood paneling. As indicated earlier, the analysis is based upon a bibliography derived from several sources, covering the period from 1960 through 1984.

27. The Effects of Temperature and Humidity on Formaldehyde Emission from UF-Bonded Boards: A Literature Critique

Myers, George E.
Forest Prod. J. 35(9): 20-31; 1985.

This is the fourth in a planned series of six critical reviews of the literature on different aspects of the problem of formaldehyde emission from adhesively bonded wood products. The six aspects being reviewed are concerned with effects of (1) formaldehyde-to-urea mole ratio, (2) ventilation rate and loading, (3) additions to wood furnish, (4) temperature and humidity, (5) post-manufacture treatments of boards, and (6) hydrolysis.

This paper analyzes the available data on effects of changing temperature or humidity (RH) on formaldehyde emission from particleboard and hardwood plywood paneling. As with the first three reviews, it is based upon a bibliography derived from several sources, in this case covering the period from 1960 through May 1984.

28. Structural Composites Research—Success and Future Challenges

Youngquist, John A.
In: Symposium on Forest Products Research International—Achievements and the Future, Vol. 6; 1985 April 22-26; Pretoria, Republic of South Africa. South African Council for Scientific and Industrial Research, National Timber Research Institute; 1985.

The research reported here has been or is being conducted (1) to provide a basis for the most effective use of wood and wood-based products, (2) to provide more options for utilizing all species and qualities of wood, so as to allow improved forest management and extend the use of the world's timber resources, and (3) to provide expertise on the scientific and technical aspects of structural wood composites to assure maximum yield from harvested trees and to assure optimized performance of composite wood products.

29. Laminated Veneer Lumber—A High Quality Structural Lumber Substitute

Youngquist, John A.
In: Symposium on Forest Products Research International—Achievements and the Future, Vol. 6; 1985 April 22-26; Pretoria, Republic of South Africa. South African Council for Scientific and Industrial Research, National Timber Research Institute; 1985.

Laminated veneer lumber (LVL) represents a design alternative for structural lumber users. Depending upon the process and species used in manufacture, a wide range of performance characteristics and product costs are possible. This paper reviews processing options, discusses research completed, and covers existing product uses. Comments are also included on the future outlook for this technology.

general

30. Progress Through Wood Research: The Forest Products Laboratory, Past, Present, and Future

Forest Products Laboratory
USDA Forest Serv., Forest Prod. Lab.; 1985.

This report contains speeches made at the general assembly and banquet of the Forest Products Laboratory's 75th Anniversary celebration on June 4, 1985. It highlights the significance of the Laboratory and presents the speakers' view of the future for forestry and wood products research.

31. An Equation for One-Sided Tolerance Limits for Normal Distributions

Link, Carol L.
USDA Forest Serv. Res. Pap. FPL 458; 1985.

An equation that does not require tables is given to determine a one-sided tolerance limit for the 100 p^{th} percentile of a normal distribution with confidence $1-\gamma$ for any sample size n. This equation gives accuracy to approximately three or more significant digits when compared to tabled values. Thus it is possible to develop an automated procedure for determining tolerance limits that is not restricted to tabled values.

32. Forest Products Research at U.S. Universities in 1982

Resch, Helmuth; Blankenhorn, Paul R.; Haygreen, John G.; Thompson, Warren S.
Wood Fiber Sci. 17(4): 568-584; 1985.

This report presents findings of a survey on professional staffing, research emphasis, and funding levels of the 37 universities in the United States that conduct forest products research. The goal was to provide an overview of the "critical mass" of wood science and technology research at U.S. universities. Much of forest products research in academia is conducted by individuals either working alone or with the assistance of a few other researchers. In the late 1970's, however, the Forest Products Laboratory (U.S. Department of Agriculture, Forest Service) in Madison, WI, initiated a number of cooperative studies with universities, thereby attracting additional talent for conducting high-priority research. At the same time, the idea of increased cooperation among universities became attractive.

material properties and construction

Constitutive Equation of Wood at Variable Humidity and Temperature

Bazant, Z. P.
Wood Sci. Technol. 19: 159-177; 1985. (Available from Information Services Division, Kurt F. Wendt Library, College of Engineering, University of Wisconsin-Madison, 215 North Randall Avenue, Madison, WI 53706; $5.)

Theoretical analysis of the effects of variations in moisture content and temperature on the creep of wood is presented. Thermodynamics of the processes of diffusion of water in wood microstructure is discussed and distinction is drawn between macrodiffusion and microdiffusion. The constitutive relation for steady states of moisture content and temperature is formulated on the basis of Maxwell chain model whose viscosity coefficients depend on moisture content and temperature. It is shown that the apparent acceleration of creep due to simultaneous drying (or wetting) as well as heating (or cooling) may be modeled as additional, stress-induced shrinkage (or swelling) and stress-induced thermal expansion (or contraction), described by shrinkage and thermal expansion coefficients that depend on the absolute values of the rates of pore humidity and temperature. Certain other sources of irreversibility of creep are also discussed.

33. Reliability Formulation for the Strength and Fire Endurance of Glued-Laminated Beams

Bender, D. A.; Woeste, F. E.; Schaffer, E. L.; Marx, C. M.
USDA Forest Serv. Res. Pap. FPL 460; 1985.

A model was developed for predicting the statistical distribution of glued-laminated beam strength and stiffness under normal temperature conditions using available long span modulus of elasticity data, end joint tension test data, and tensile strength data for laminating-grade lumber. The beam strength model predictions compared favorably with test data for glued-laminated beam strength data with 8 and 10 laminations; however, the model predicted strength values 30 percent higher for glued-laminated beam strength data with 4 laminations.

Fire endurance and structural resistance were evaluated by artificially reducing the cross section. This reduction accounts for char depth as well as for reduced wood strength caused by the elevated temperature. Average time-to-failure predictions using the developed model compared well with those from conventional prediction methods.

34. A Chemical Kinetics Approach to the Duration-of-Load Problem in Wood

Caulfield, D. F.
Wood Fiber Sci. 17(4): 504-521; 1985.

The theory of absolute rates of chemical processes is presented as an appropriate conceptual framework for understanding the creep-rupture phenomena of duration of load (DOL) and rate of loading (ROL). The theory predicts the following experimentally observed phenomena: (1) The logarithm of the time to failure under constant deadload stress increases linearly as the stress level is decreased and (2) The rupture strength in a linear-ramp ROL experiment increases with the logarithm of the rate of stressing.

Moreover, the equations derived to describe these phenomena contain the same parameters. These parameters are defined physical quantities that describe the creep characteristics of the material. It is possible to predict how long a material will support a constant deadload stress (DOL behavior) from measurements of apparent rupture strength as a function of the rate of stressing in a linear-ramp loading experiment (ROL behavior).

Rupture of Douglas-fir in bending is selected as an example, and the experimental results from ROL-behavior experiments are used to predict DOL behavior. The theory adequately describes the experimentally observed results.

35. Determination of Modulus of Rigidity by ASTM D 198 Flexural Methods

Gromala, David S.
J. Test Eval., JTEVA. 13(5): 352-355; 1985.

This paper examines the sensitivity of the traditional equations to various parameters and concludes that the edition of 1983 and the previous editions of ASTM Methods for Static Tests of Timbers in Structural Sizes (D 198) were not suitable for determination of shear modulus in structural lumber. An alternative test method currently used in Europe was proposed. Based on the considerations in this paper, this method was adopted in the 1984 edition of ASTM D 198.

36. Lateral Nail Resistance for Ten Common Sheathing Materials

Gromala, David S.
Forest Prod. J. 35(9): 61-68; 1985.

The lateral resistance of fasteners is the controlling property governing racking strength and stiffness of light-frame walls. Composite action in floors, walls, and roofs also depends upon fastener stiffness. The objective of this study was to develop lateral nail resistance data for some of the most commonly used wall sheathing materials. Sheathing materials tested include plywood, flakeboard, hardboard, and gypsum board. Comparison of cycled versus uncycled loading showed no appreciable difference in strength. Characterization of the load-slip relation by a linear slip modulus is shown to be sensitive to choice of slip level and highly subjective. The results of this study should be useful in helping researchers plan the scope of future studies by identifying the need to focus on a specific slip region before attempting to define a slip modulus.

37. Does Mechanical Stress Affect the Dielectric Properties of Wood?

James, William L.
Wood Fiber Sci. 17(3): 365-368; 1985.

The effect of mechanical stress on the dielectric properties of wood was studied to assess the possibility of estimating drying stresses from dielectric measurements. The effect was observable for both the mechanical and electric stress parallel to the grain when the wood was at 12% moisture content or greater and at frequencies less than about 10 kHz. For stresses across the grain, the effect was very small, which precludes using this phenomenon for estimating drying stresses.

38. Flamespread Variability of Candidate Wood-Based Reference Materials

LeVan, Susan L.
J. Fire Sci. 3: 208-223; May/June 1985.

The author determined the flamespread variability of four wood composite panel products that were being considered as possible standard reference material, and also examined the effect of density, moisture content, heating rate, thermal conductivity, and specific heat on this variability. Of these, density has the greatest effect on variability. Of the four types of materials tested, material C had one of the smallest density variabilities. It is recommended that this material be used in ASTM E 84 tests to establish its use as a standard reference material for flamespread tests, and that material selection and statistical design procedures outlined in this paper be followed.

39. Sheathing Properties and Component Performance in Light-Frame Structures

Moody, Russell C.; McCutcheon, William J.
In: Robertson, Doris, coord. Structural wood composites: Meeting today's needs and tomorrow's challenges: Proc. 7339; 1984 November 12-14; Minneapolis, MN. Madison, WI: Forest Prod. Res. Soc. 1985: 93-99.

Panel products are important in modern light-frame structures. They provide the exterior and interior wall sheathings, the roof covering, and subfloor and underlayment. The authors examined the various structural roles which panel products play in conventional light-frame construction, i.e. construction which comprises repetitive parallel-framing members and panel-type sheathing products.

40. Test Methods for Basic Properties of Wood-Base Panels: Past Experience, Today's Needs

McNatt, J. Dobbin
In: Maloney, Thomas M., ed. Proceedings of the 18th Washington State University International Particleboard/Composite Materials Series Symposium; 1984 March 27-29; Pullman, WA. [Pullman, WA]: Washington State University; 1984: 227-239.

As originally published, American Society for Testing and Materials ASTM Standard D 1037 contained small-specimen tests for fiber-based panels. This paper compares various D 1037 test methods with similar American Society for Testing and Materials construction plywood tests. It discusses the need for a flexural creep test. It also discusses and presents possible alternatives for some D 1037 tests which are not appropriate for wood-base construction panels for reasons other than specimen size.

41. Light-Frame Shear Wall Length and Opening Effects

Patton-Mallory, Marcia; Wolfe, Ronald W.;
Soltis, Lawrence A.; Gutkowski, Richard M.
J. Struct. Eng. 111(10): 2227-2239; 1985.

Standard methods of testing the racking capacity of light-frame walls are inefficient and may give erroneous estimates of shear wall performance. This study is concerned with improving the data base for racking resistance of light-frame walls with plywood and gypsum sheathings. The shear resistance of small walls sheathed with gypsum was compared to that of full-size walls. Results of both tests indicated that racking strength was linearly proportional to wall length.

42. Weak Wood: Fast-Grown Trees Make Problem Lumber

Senft, John F.; Bendtsen, B. Alan; Galligan, William L.
J. Forestry 83(8): 477-484; 1985.

The authors discuss the problems connected with juvenile wood from fast-grown trees. They discuss juvenile wood, reaction wood, shrinkage, warpage, commercial limits, and implications for foresters.

43. Condensation Potential in High Thermal Performance Walls—Hot, Humid Summer Climate

Sherwood, Gerald E.
USDA Forest Serv. Res. Pap. FPL 455; 1985.

Studies were conducted to evaluate the potential detrimental effects of moisture accumulation in wall cavities in both a cold climate and in a hot, humid climate with a long air-conditioning season. Results from the cold climate were reported in a previous paper (Sherwood 1983). Results from a hot, humid climate—i.e., Gulfport, Mississippi—are reported in this paper. In that location, average temperatures during summer months are 80 to 83 °F with frequent highs approaching 100 °F. Average relative humidities during summer months are 85 percent at 4 a.m. (coldest time of day) and 64 percent at 1 p.m. (warmest time of day).

This study is part of an ongoing program of thermal/moisture research at the Forest Products Laboratory (FPL) to determine the potential for condensation in walls. Because all variables could not be considered in a single study, additional studies are planned in both controlled laboratory tests and field observations of complete houses.

44. Partially Continuous Floor Joists

Soltis, Lawrence A.
USDA Forest Serv. Res. Pap. FPL 461; 1985.

Floor joists are designed as single-span simply supported beams. The feasibility of reducing joist size by forming partially continuous joists is reported. The partially continuous joists are formed by moment connections at the center support of a two-span beam. Three connection types were investigated: Truss plates, finger joints, and glued plywood side plates. Three sizes of joists—2 by 6, 2 by 8, and 2 by 10 and high and low density species—were included. The results indicate it is feasible to develop partial continuity by a moment connection at the center support. However, specific design criteria cannot be made until connection design procedures are further developed.

45. Strength of Nailed Wood Joints Subjected to Dynamic Load

Soltis, Lawrence A.; Mtenga, Primus V. A.
Forest Prod. J. 35(11/12): 14-18; 1985.

Design criteria for lateral resistance of nailed joints are based on static load tests, whereas earthquake and wind produce dynamic loads of structures. This study compares lateral nail resistance determined by static and cyclic loading to determine if static load design criteria apply to dynamically loaded structures. Two joint configurations were tested dynamically at 1- and 10-Hz cyclic frequency and compared to static tests. The two configurations consisted of a Douglas-fir lumber main member connected by a single nail to either a plywood or Douglas-fir lumber side member. The comparisons indicate that at small deformations the increase in joint capacity due to higher rate of loading is offset by decreased joint capacity due to load cycling. At large deformations and numbers of load cycles, joint resistance decreases.

Continuous Timber Diaphragms

Tarpy, Thomas S., Jr.; Thomas, David J.; Soltis, Lawrence A.
J. Struct. Eng. 111(5): 992-1002; May 1985. (Available from Information Services Division, Kurt F. Wendt Library, College of Engineering, University of Wisconsin-Madison, 215 North Randall Avenue, Madison, WI 53706; $5.)

Current design assumptions for diaphragms assume support conditions which are either simple span or fully continuous. The building codes require a design based on the highest values for moment and shear obtained under either of these two support conditions. More practical criteria for assessing continuity conditions at supports for wood diaphragms are needed. This investigation is to determine experimentally the effects of continuity conditions on timber floor diaphragms with plywood sheathing subject to inplane loads. Previous testing programs have evaluated simply-supported diaphragms subject to uniform loading; this study evaluates the effects of other support conditions and non-uniform loads. Static loading conditions were used to evaluate the response of the diaphragm for both deflection and ultimate strength.

46. Steady-State One-Dimensional Water Vapor Movement by Diffusion and Convection in a Multilayered Wall

TenWolde, A.
ASHRAE Trans. 91(1): 322-342; 1985.

Current moisture analysis methods for walls ignore air leakage effects or are not directly applicable to multilayered walls. Mathematical equations were developed for water vapor flow, vapor pressures, and moisture accumulation under steady-state conditions with homogeneous one-dimensional airflow through a multilayered wall. A computer method was developed on the basis of these equations. With this method, a better qualitative understanding may be gained of the effects of air leakage on moisture accumulation.

47. Reporting of Fire Incidents in Heavy Timber Structures

White, Robert H.
USDA Forest Serv. Res. Pap. FPL 464; 1985.

This investigation of fire incidents in heavy timber construction is based solely on the 1977-1981 data files of the National Fire Incidents Reporting System (NFIRS) of the Federal Emergency Management Agency. Buildings of heavy timber construction usually consist of interior columns, beams, and floors of wood and exterior walls of noncombustible construction. About half of the reported incidents involved one of two types of fixed property use which present different types of fire problems: either one- and two-family dwellings or agricultural products storage structures (barns and stables). Both types of structure are likely not to meet the building code definition of heavy timber or type IV construction, although they have heavy timber members.

The main conclusions are (a) there is a need to clarify and improve the coding both for type of construction and for extent of fire damage, (b) solid fuel heating systems are the major cause of fires in the residential "heavy timber" structures, and (c) fires of incendiary or suspicious origin are a significant portion of the agricultural product storage fires.

mycology

48. Hawaiian Forest Fungi V. A New Species of *Phellinus* (Hymenochaetaceae) Causing Decay of *Casuarina* and *Acacia*

Larsen, Michael J.; Lombard, Frances F.; Hodges, Charles S., Jr.
Mycologia. 77(3): 345-352; 1985.

A previously undescribed species, *Phellinus kawakamii*, is reported to cause decay of heartwood in the butt portion of trees of *Acacia koa* var. *koa*, *A. koaia*, and *Casuarina equisetifolia* on Kauai, Oahu, and Hawaii in the Hawaiian Islands. Limited surveys, based on the occurrence of basidiocarps, indicate that at least 28-33% of the *Casuarina* trees and 12% of the *Acacia koa* var. *koa* trees examined are affected by the fungus. Although the fungus causes a white pocket-rot in all species, the morphology of the rot differs noticeably between *Casuarina* and the two *Acacia* spp.

packaging

49. Conventional and Press Drying of High-Yield Paper Birch for Use in Linerboard and Corrugating Medium

Horn, Richard A.; Bormett, David W.
Tappi J. 68(10): 97-101; 1985.

Linerboard and corrugating medium of good strength can be made from high-yield, unrefined paper birch kraft pulp by both conventional and press-drying processes. However, press-drying produces a much stronger linerboard and corrugating medium than is achieved by conventional drying. The corrugated fiberboard containers exceeded the performance of similar containers made from commercial, conventionally-dried 100% pine kraft fiber linerboard and hardwood NSSC medium. There was one exception: impact resistance for the paper birch containers was lower than that of pine kraft-NSSC containers, but the data suggest that impact performance can be improved. Paper birch fiber is suitable for linerboard and thus should provide some incentive to utilize birch in high strength products.

50. Packaging Perspective: 1910-1985

Koning, John W., Jr.; Laundrie, James F.
USDA Forest Serv. Gen. Tech. Rep. FPL-51; 1985.

For 75 years the Forest Products Laboratory has been concerned for the wise use of wood. One of the major uses of wood is packaging. This report summarizes the research reports completed in packaging and relates the output in terms of forest management and return on the taxpayer's investment.

51. A Method for Determining the Effect of Fasteners on the Stiffness and Strength of Wood Drive-In-Rack Pallets

Urbanik, Thomas J.
J. Test. Eval., JTEVA. 13(5): 379-386; 1985.

Wood pallets are increasingly stored in warehouses with drive-in or drive-through racks. A pallet needs adequate stiffness and strength to function safely under conditions where it spans the rack support rails. When the stringers run parallel to the supports, the fasteners reinforce the deckboard load-carrying ability. This report experimentally determines the effect of fasteners on pallet performance. The effect is characterized in terms of the ratio of the joint rotation modulus to a normalized deckboard bending stiffness. This approach enables the joints to be compared with pinned and rigid joints in a pallet stiffness and strength theory.

52. Rotational Characteristics of Pallet Joints

Wilkinson, Thomas Lee
USDA Forest Serv. Res. Pap. FPL 457; 1985.

During its lifespan, a pallet must withstand its imposed load without endangering its contents or the people handling it. To determine the amount of load a pallet will withstand requires a sound engineering analysis. The moment-rotation behavior of the joints between deckboards and stringers is needed for input to such an analysis. This report describes the joint behavior as affected by (1) deckboard species, (2) stringer species, (3) type of fastener, and (4) fastener pattern. The behavior is described by a mathematical model.

preservation and protection

53. Efficacy of Various Fumigants in the Eradication of Decay Fungi Implanted in Douglas-fir Timbers

Eslyn, W. E.; Highley, T. L.
Phytopathology. 75(5): 588-592; 1985.

The fumigants Vapam and chloropicrin effectively control *Poria carbonica* Overh. and *P. placenta* (Fr.) Cke. in large heavily checked, Douglas-fir wharf timbers. However, because decay fungi vary in tolerance to different fumigants, we did not know whether fumigation would successfully eradicate other important fungi that decay Douglas-fir wood products. This study was initiated primarily to provide this information. Other objectives of the study were to determine the efficacy of other untested chemicals for use as eradicants of wood decay fungi, the extent and speed of penetration of toxic amounts of test fumigants through horizontally oriented Douglas-fir timbers, and the longevity of toxic concentrations of fumes in that wood.

54. The Moisture-Excluding Effectiveness of Finishes on Wood Surfaces

Feist, William C.; Little, James K.; Wennesheimer, Jill M.
USDA Forest Serv. Res. Pap. FPL 462; 1985.

The primary objective of the work reported here was to measure the moisture-excluding effectiveness of a wide range of commercially available surface treatments and finishes on wood. The authors studied the important variables of film thickness, wood species and substrates (plywood, hardboard, flakeboard, etc.), and time. The studies were restricted to the measurement of the effectiveness of finishes on wood against water vapor between 30 and 90 percent relative humidity at 80 °F. This paper should be useful to builders, architects, wood furniture manufacturers, those who make wood finish formulations, and anyone else interested in controlling water vapor movement into or out of wood. The information will benefit those who need to select wood finishes with specific moisture-excluding effectiveness.

The Moisture-Excluding Effectiveness of Finishes on Wood Surfaces—Support Data

Feist, William C.; Little, James K.; Wennesheimer, Jill M.
(Copies available from National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161; $9.95; PB 86147717/AS.)

Three extensive tables present complete data from large experiments that have been summarized and discussed in another paper by the same authors: "The moisture-excluding effectiveness of finishes on wood surfaces" (USDA Forest Service Research Paper FPL 462). Table 1 shows the moisture-excluding effectiveness (MEE) on ponderosa pine sapwood of 1, 2, and 3 coats of each of 91 commercial finishes, for 1, 7, and 14 days of exposure to 90 percent relative humidity, and MEE values beyond 14 days for any finish that had MEE greater than 50 percent. Table 2 gives the MEE of three of the finishes applied to a variety of other substrates, for varying thickness of film and time of exposure. Table 3 lists name, description and composition of each of the 91 finishes evaluated in these tests.

55. Early Detection of Brown Rot Decay in Douglas-Fir and Southern Yellow Pine by Infrared Spectrophotometry

Gibson, David G.; Krahmer, Robert L.; DeGroot, Rodney C.
Wood Fiber Sci. 17(4): 522-528; 1985.

Samples of Douglas-fir heartwood and southern yellow pine sapwood were incubated with several brown rot fungi and examined for decomposition as shown by weight losses (to 10%). Warm-water extracts from the samples were analyzed by infrared spectrophotometry. An absorption peak at 1,720 cm^{-1} appeared in infrared spectra of decayed specimens but was not present in nondecayed specimens. As weight loss increased, the ratio of the absorbance at 1,720 cm^{-1} to the absorbance at 1,630 cm^{-1} increased. The ratio correlated with days of incubation and modulus of rupture.

Using Sodium N-Methyldithiocarbamate to Exterminate the Pine Wood Nematode in Wood Chips

Kinn, D. N.; Springer, E. L.
Tappi J. 68(12): 88; 1985. (Copies available from D. N. Kinn, Research Entomologist, Southern Forest Experiment Station, USDA, 2500 Shreveport Highway, Pineville, LA 71360.)

The pine wood nematode is endemic in North America, and native species of pine are partially resistant to pine wilt disease. Preliminary studies indicate that steam heat or immersion in hot water will kill nematodes within wood chips. This method has the disadvantage of increasing chip weight. The exploratory study reported here indicates that treating chips with sodium N-methyldithio-carbamate may provide a more practical means for killing the pine wood nematodes in them.

56. Water Repellency and Dimensional Stability of Wood

Rowell, Roger M.; Banks, W. Bart
USDA Forest Serv. Gen. Tech. Rep. FPL-50; 1985.

A discussion of the interaction between wood and water makes clear the distinction between water repellency of wood (a rate of change) and dimensional stability (a level of equilibrium). A review of methods of treating wood follows, leading to comparison of their effectiveness, description of test procedures to evaluate treatments, and discussion of deficiencies of the tests commonly used, first with regard to water repellency, then to dimensional stability, with final consideration of future research. Figures, numerous tables (introducing some new data), and an extensive bibliography illustrate the discussion.

57. Design of Fire-Resistive Coated Wood Members

White, Robert H.
In: Spinna, Robert J., Jr., ed. Retrofitting, Maintenance and Management for Fire Safety—The Role of Engineering, Education and Enforcement: Proceedings of the 3d Annual Fire Engineering Conference; 1985 June 3; Riverdale, NY. Riverdale, NY: Manhattan College Fire Engineering Institute; 1985: 107-125.

The author reviews proposed design procedures for adding fire-resistive coatings to increase the fire endurance of walls, floors, and heavy timber members, and also presents an update on advances in fire endurance design of structural wood members and assemblies.

58. Wood Modified by Inorganic Salts: Mechanism and Properties. I. Weathering Rate, Water Repellency, and Dimensional Stability of Wood Modified with Chromium (III) Nitrate Versus Chromic Acid

Williams, R. S.; Feist, W. C.
Wood Fiber Sci. 17(2): 184-198; 1985.

Treatments with hexavalent chromium compounds have not been commercialized because of their toxicity and the green color the trivalent chromium imparts to wood. However, a better understanding of the mechanism by which these compounds improve wood performance may lead to the development of comparable or better treatments. This paper reports further on the chromium mechanism, particularly the role of hexavalent chromium oxidation in the modification of wood surfaces. The objective of the study was to determine if trivalent chromium compounds that fix to wood such as chromium (III) nitrate nonahydrate ($Cr(NO_3)_3 \cdot 9H_2O$), chromium (III) sulfate hydrate ($Cr_2(SO_4)_3 \cdot xH_2O$), and chromium (III) acetate hydrate ($Cr(C_2H_3O_2)_3 \cdot xH_2O$) would form a wood-chromium complex similar to chromic acid and thus give similar improved performance in weathering and finishing.

59. Interaction of CCA Preservative Treatment and Redrying: Effect on the Mechanical Properties of Southern Pine

Winandy, J. E.; Boone, R. S.; Bendtsen, B. A.
Forest Prod. J. 35(10): 62-68; 1985.

Preservative treatment with chromated copper arsenate (CCA) and kiln redrying can adversely affect the mechanical properties of southern pine. Statistical models were developed to quantify the response between CCA retention and the kiln-drying temperature. These models were used to establish guidelines for current Forest Products Laboratory studies on the response of CCA-treated southern pine dimension lumber.

processing of lumber

60. A Technique for Simulating Lumber Drying Using Small Clear Specimens

Boone, R. S.; Winandy, J. E.; Bendtsen, B. A.
Forest Prod. J. 35(11/12): 49-51; 1985.

Researchers studying the effects of chemical treatments or environmental influences on wood often prefer to use small clear specimens rather than full-size ones. This substitution does not work well when kiln-drying is involved in the experiments. Simulating in small clears these drying effects which would be found in full-size lumber is a problem because time, temperature, and moisture gradients all interact with size. This paper presents a method for simulating the effects of kiln-drying nominal 2-inch lumber using 1- by 1- by 18-inch specimens. This technique exposes small specimens to kiln temperatures for the same time required to dry full-sized lumber. Moisture loss in the small specimens is delayed by placing them in heat-resistant polyethylene bags. The technique should be applicable to drying simulations in the 110 to 250 °F range.

61. An Economic Model for Life-Cycle Cost Analyses of Sawmilling Operations

Harpole, G. B.
In: Symposium on Forest Products Research International—Achievements and the Future, Vol. 3; 1985 April 22-26; Pretoria, Republic of South Africa. South African Council for Scientific and Industrial Research, National Timber Research Institute; 1985.

Life-cycle cost (LCC) analysis is a technique for accounting all production costs over the life of an operation, and expressing such costs in terms of required revenues. This paper briefly describes the basic concepts of LCC, and briefly describes a computer program available from Harpole that may be used for LCC analysis.

62. Productivity Improvement: Real or Imagined?

Harpole, George B.; Lunstrum, Stanford J.
In: Robertson, Doris, coord. Sawing technology: The key to improved profits: Proc. 7322; 1984 January 30-February 1; San Antonio, TX. Madison, WI: Forest Prod. Res. Soc.; 1985: 5-15.

Real productivity improvements yield increases in operating profits. The purpose of this paper is to show how to estimate likely changes in operating profits that may be associated with sawmill changes, and how to use these estimates to calculate rates-of-return on the costs for improvements. Formulas and programs for programmable calculators are also given as additional aids.

63. Yield Losses From Sawmill Scanner Error

Lewis, David W.
USDA Forest Serv. Res. Pap. FPL 459; 1985.

The sawmill industry is using automated control systems to augment or, in some cases, replace human observation and decisionmaking. The rapid implementation of these systems for primary log breakdown has resulted from technological advances in optical scanners, computers, and simulation modeling. Even though scanners have been greatly improved, most, if not all, of those being used in sawmills are to some degree imprecise, inaccurate, or both. This imprecision and/or inaccuracy results in lost yield through choice of the "wrong" sawing pattern, i.e., a pattern optimal for a larger or smaller diameter log. There is no information available quantifying these losses; and, because most automated log breakdown control systems give reasonable results, many people in the sawmill industry do not realize a problem exists. Even where the problem has been recognized, without quantifying data it has been impossible to determine the economic feasibility of correcting it. The results of the study discussed in this paper quantify the losses in lumber recovery resulting when the "wrong" sawing pattern is used by an automated log breakdown control system. This information can be used by sawmill managers and equipment manufacturers in determining specifications for new systems or modifications to existing ones.

64. High-Temperature Drying and Equalizing: Effects on Stress Relief in Yellow-Poplar Lumber

Maeglin, Robert R.; Liu, Jen Y.; Boone, R. Sidney
Wood Fiber Sci. 17(2): 240-253; 1985.

Warp caused by longitudinal growth stress has limited the use of hardwoods for some products such as structural lumber. This study evaluates the effects of high-temperature drying and equalizing times on relief of longitudinal growth stress. Small-diameter yellow-poplar logs were sawn into flitches for evaluation of total stress levels in green flitches and final stress levels in dried flitches. There were no well-correlated relationships of stress between the individual high-temperature or equalizing treatments and controls or green flitches. Possible causes for lack of correlation and suggestions for further research are discussed.

65. Drying North American Oak Lumber—The Bacterial Problem

Ward, James C.; Hart, C. Arthur
In: Mitchell, Philip H., comp. Proceedings of the North American Wood Drying Symp.; 1984 November 27-28; Mississippi State, MS. Mississippi State, MS: Mississippi Forest Products Utilization Laboratory. [1985]: 90-96.

Oak lumber sawn from trees infected with anaerobic bacteria is more prone to check and honeycomb than lumber from non-infected trees. The effect of commercially available drying methods on magnitude of drying defects is discussed. Bacterially infected oak appears to be increasing and research on presorting and improved drying systems is encouraged.

pulp and paper

Raman Microprobe Studies of Fiber Transformations During Press-Drying

Atalla, R. H.; Woitkovich, C. P.; Setterholm, V. C.
Tappi J. 68(11): 116-119; 1985. (Copies available from The Institute of Paper Chemistry, Appleton, WI 54912.)

The effect of press-drying on the state of molecular aggregation in pulp fibers has been studied using Raman spectroscopy and x-ray diffraction. The results have revealed a tendency for cellulose molecules to aggregate at a high rate when pulp fibers are subjected to elevated temperatures in the presence of moisture. This phenomenon may be a key factor in development of the desirable properties of press-dried sheets.

Biaxial Strength of Paperboard Predicted by Hill-Type Theories

Rowlands, R. E.; Gunderson, D. E.; Suhling, J. C.; Johnson, M. W.
J. Strain Analysis. 20(2): 121-127; 1985. (Available from Information Services Division, Kurt F. Wendt Library, College of Engineering, University of Wisconsin-Madison, 215 North Randall Avenue, Madison, WI 53706; $5.)

Paperboard strength under biaxial normal plus shear stresses is predicted using Hill-type criteria (including Tsai-Hill, Norris, Fischer, and Ashkenazi). Results are compared throughout all four quadrants with experimental data obtained from on- and off-axis uniaxial coupons, cylinders, and cruciform specimens. The Norris and Fischer theories predict observation quite well except at higher values of shear stress where they become too conservative. The Tsai-Hill theory is conservative throughout. Simplicity of both analysis and implementation, plus need for only minimal experimental input data, are significant advantages of Hill-type criteria. Moreover, their reliability for paper is comparable to that of other published results. Other strength theories will be addressed in subsequent papers.

timber requirements and economics

66. Prospective U.S. Timber Supply and Demand Situation and Implications for World Trade

Darr, D. R.; Harpole, G. B.
In: Symposium on Forest Products Research International—Achievements and the Future, Vol. 3; 1985 April 22-26; Pretoria, Republic of South Africa. South African Council for Scientific and Industrial Research, National Timber Research Institute; 1985.

The prospective timber demand-supply situation in the United States indicates there will be increasing competition for all forest products. Timber product prices are likely to show continued increases relative to other prices in the United States and other major timber producing and consuming countries. These increases will provide incentives for intensified management, and adoption of new technologies for development of unused forest resources. Research to develop additional knowledge will lead to new opportunities for extending timber supplies. It is from these opportunities that the greatest improvements may come. Increased attention to ways of extending wood supplies and reducing timber products requirements is essential to long-term success in living within resource constraints. The opportunities discussed suggest that technologies are available, or could be made available, to greatly reduce the potential impacts of rising prices of timber products and alleviate possible shortages of nonrenewable resources, including fossil fuels.

67. Opportunities for Techno-Economic Applications in World Forestry

Harpole, G. B.
In: Symposium on Forest Products Research International—Achievements and the Future, Vol. 3; 1985 April 22-26; Pretoria, Republic of South Africa. South African Council for Scientific and Industrial Research, National Timber Research Institute; 1985.

Techno-economic methods are used to measure forest resources, to measure demands for forest benefits and products, and for measuring costs for production of such benefits and products in comparison to alternative resources. Because of the changing needs and opportunities of the world, the need for developing new techno-economic methods continues to be of paramount importance.

68. A Computer Program for Analysis of Fuelwood Harvesting Costs

Harpole, George B.; Rensi, Giuseppe
USDA Forest Serv. Gen. Tech. Rep. FPL-46; 1985.

The fuelwood harvesting computer program (FHP) is written in FORTRAN 60 and designed to select a collection of harvest units and systems from among alternatives to satisfy specified energy requirements at a lowest cost per million Btu's as recovered in a boiler, or thousand pounds of H_2O evaporative capacity kiln drying. Computed energy costs are used as a criterion of economic viability. Sensitivities of energy costs and fuel requirements to changes in moisture content are computed and provided in the printed output.

Innovation and Productivity Change in the Structural Panel Industry

Haygreen, John; Gregersen, Hans; Hyun, Andrew; Ince, Peter
Forest Prod. J. 35(10): 32-38; 1985. (Available from Forest Products Research Society, 2801 Marshall Court, Madison, WI 53705; $2 each, with $5 minimum, plus 10% postage and handling.)

Innovation and productivity change in the structural panel industry is traced to favorable economic circumstances prevailing in the 1970s and to research that was accomplished over several decades. The research effort measured in numbers of publications was followed after a lag of 8 to 10 years by a parallel and proportional increase in production capacity equipped with new structural panel technology. Constant interactions are observed between research effort and needs and opportunities of the industry, especially in the 1970s. Finally, development of the new structural panel technology resulted in significant labor and material productivity improvements in the manufacture of structural wood panels. This report concludes that research innovation played an important role in development of the structural panel industry and helped to improve productivity in manufacture of structural wood panels. This report is significant because it ascertains that forest products research contributes to development of successful new products and improvements in productivity.

69. Modeling the Demand for Wood Products in the Context of Technological Change

Spelter, Henry
In: Hadley, M. J.; Williams, D. H., ed. Proceedings of the 3d North American IIASA [International Institute for Applied Systems Analysis] Network Meeting; 1985 March 21-23; Victoria, BC. [Vancouver, BC]: Forest Economics and Policy Analysis Project; 1985: 113-122.

This study was conducted to determine how technological change has affected the response of softwood lumber and softwood plywood demand to prices since World War II. The results of the analysis indicate that the price elasticities of demand for softwood lumber and softwood plywood have declined since World War II.

70. A Product Diffusion Approach to Modeling Softwood Lumber Demand

Spelter, Henry
Forest Sci. 31(3): 685-700; 1985.

The price elasticity of demand plays an important role in determining softwood lumber consumption. The specification of this relationship is of special interest to national assessment methodology since, in the long-range projections employed there, the demand elasticity is necessary to determine the full impacts of policy alternatives. The present study was conducted to determine how technological change has affected the response of softwood lumber demand to its price since World War II. The analysis indicates that projections of future price elasticities should be made in the context of the technologies that are expected to play a market role in the projection interval.

71. A Profile of the Nonresidential Nonbuilding Construction Market for Lumber and Plywood

Spelter, Henry
USDA Forest Serv. Resour. Bull. FPL 16; 1985.

Estimates of the amounts of lumber and plywood used in constructing nonresidential nonbuilding structures in 1982 are presented. The market is stratified by six construction types. Lumber and plywood use is stratified by two end-use categories. Total lumber use is estimated at 507 million board feet. Total plywood use at 362 million square feet (3/8-in. basis). Estimates of lumber and plywood use in nonresidential building construction are presented in a separate report.

72. Efficiency of Softwood Sawmills in the Southern United States in Relation to Capacity

Steele, Philip H.; Risbrudt, Christopher D.
Forest Prod. J. 35(7/8): 51-56; 1985.

Large sawmills in the South took over much of the market share of small sawmills in a 10-year period, 1966 to 1976. Apparently, large mills are currently in a better competitive position relative to smaller mills. The exact reasons for this are not clear although various authors point to both in- and out-of-plant factors. The role that conversion efficiency may play in allowing large sawmills to compete more effectively has not previously been examined. Data from numerous studies on lumber recovery factor (LRF), lumber variation, lumber sizing, cubic production, and kerf width were analyzed. It was found with few exceptions that the larger a mill is, the better it performs as regards these variables. The evidence presented here shows that, in general, as mills get larger they compete more effectively in terms of conversion efficiency. More salable product per unit of raw material is obtained. This factor has no doubt been of importance in the increase in market share of large mills at the expense of those of smaller size in recent years.

73. Wood Products Use by Coal Mines

Stone, Robert N.; Risbrudt, Christopher; Howard, James
Forest Prod. J. 35(6): 45-52; 1985.

This study of wood use in mining includes a survey of 220 coal mining firms to estimate quantities used in 1979. Consumption of wood products by coal mines has gradually declined since 1923. Recent increases in coal production have led to increases in the consumption of wood products by the mine. The kind of timber used differed by region. Hardwood use is about 40 times greater than softwood use in the eastern region. There, hardwoods are plentiful, relatively cheap, and strong. In the West where softwood forests predominate, softwoods were 2-1/2 times more common in mine-wood use than hardwoods.

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